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Collision Object Detection and Prevention of Train Accident Dynamically by Using Ultrasound and Embedded System

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Abstract - *Railway is the most popular and friendly transportation system of the largest part of the cities in the world. Train is widely used for comfortable and safe journey in a reasonable fare. People from different professions can effort it. Almost 10,000 billion freight tonne-Kilometers and more than 5 billion Passengers of rail transport have been travelled around the world per years. The railway transportation system plays an important role for business as well as for leniency and safe travelling in modern life. But at every turn, the train is facing unexpected situation in travelling because of wrong signal, wrong track switching, insecure level crossing etc. for which collision have been occurred. As a result, lot of damages has been done in economic sector with lot of causalities which affect our progress. But we can avoid this unexpected collision and take prevention from the accident dynamically by using the collision detection technology which can be made by ultrasonic sound with a special embedded system. By using this technology can detect the obstacle and gradually slow down the speed by initiating the air brake to stop the train before the collision takes place.*

Key Words: **Ultrasonic Sensor, Microcontroller board, Control Device, Alarm, DC Servo motor, Embedded System.**

1. INTRODUCTION

Railway is the most popular and friendly transportation system in the world. Rail transports are facing major challenges in our day to day life. Rail transport systems first appeared in England in 1820s. From 1820-2016 many evolution is occurred. At present railways is one of the most widely used transportation system in the world. Approximately 10,000 billion freight tonne-Kilometres are travelled around the world every year and more than 5 billon passengers travelled per year as per Railway statistic report. Economists have argued that the existence of modern rail infrastructure is a significant indicator of a country's economic advancement. But till now railway transportation system are not safe. Many countries's railway faces many collisions during travelling in every year as a results happened lot of damages and casualties. But if we add Anti-Collision Technology (ACT) in railway then we can prevent any types of collision. It is an innovative technology which can be detect collision object from specific distance of train and avoid collision dynamically and efficiently by using ultrasound and embedded system.

2. TRAIN ACCIDENT

The train accident is one of the most dangerous accidents ever. The common reason of the train collisions are malfunctioning train signals or lights, failing mechanics, safety gates not in place ,crossings that are unprotected, negligence of train conductor and lack of awareness of the people.

2.1 Train Collision in Different Countries

Every year in many countries around the world occurred train accidents. Here are some accidents have been highlighted.

I. 8 December 2010 – Bangladesh – Two passenger trains are in a head-on collision near Narsingdi. Nineteen people are killed.
II. 15 September 2010 – Belgium – Two trains collide at Aarlen, injuring 30–40 people, two seriously.
III. 2 October 2010 – Indonesia – 2010 Petarukan train collision - 36 people are killed and 60 are injured when a train runs into the back of another at Petarukan.
IV. 12 October 2010 – Ukraine – 2010 Marhanets train and bus collision - At least 43 people are killed in a collision between a train and a bus at Marhanets.
V. 19 July 2010 – Sainthia train collision occurred at Sainthia railway station in Sainthia, when the Uttar Banga Express collided with the Vananchal Express. Casualties stand at 63 people dead and more than 165 people injured.
VI. 20 May 2011 – South Africa – 857 people are injured, 25 seriously, when a rear-end collision occurs at Soweto.
VII. 23 July 2011 – China – Wenzhou train collision – Due to signal failure, a high-speed train rear-ends a stopped high-speed train at a speed of 99 km/h (62 mph) near Wenzhou in the province of Zhejiang, killing 40 people and injuring at least 192.
VIII. 11 January 2012 - 5 persons were killed and 9 others, including a child, injured in a collision between the Delhi-bound Brahmaputra Mail and a stationary goods train.

IX. 22 May 2012 - The Hubli-Bangalore, Hampi Express collided with a goods train near Penukonda in Andhra Pradesh. 14 people were dead and 35 were injured in the collision.

X. 24 July 2014 – India – Medak district bus-train collision – A school bus is hit by Nanded Passenger train at an unmanned railway level crossing in Masaipet village of Medak district. 18 bus passengers died including 16 students.

XI. 15 September 2016 -A Karachi-bound express train has collided with a stationary freight train in Pakistan's central Punjab region, killing at least 6 people and injuring more than 150.

XII. 3 November 2016-At least 20 people were killed and nearly 70 injured when Zakaria Express collided into stationary coaches of Fareed Express at a railway station in Karachi. The engine of one train was completely destroyed.

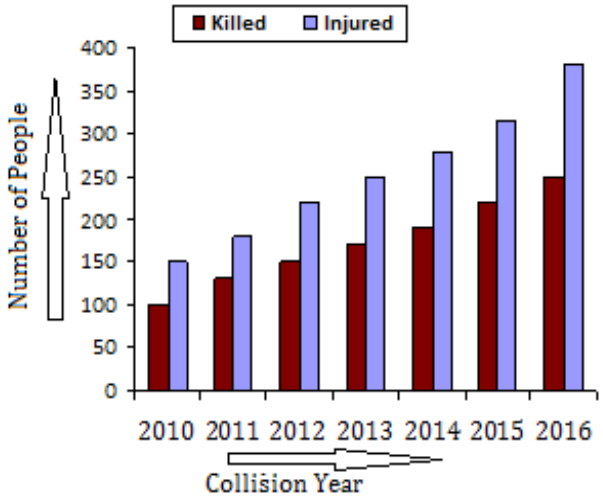

Chart-1: Survey chart on train collision.

Chart-1 represents approximate quantity of killed people and injured people in last seven years train collision around the world.

3. PROPOSED SYSTEM

This proposed Anti-Collision System (ACS) will have the significant impact on the railway safety. This Anti-Collision System (ACS) is made by ultrasonic sensor with microcontroller depended embedded system which can work on emergency air brake to control a high speedy train. Ultrasonic sound is used to measure the distance using sensor. When it detects any obstacle in front of the train then it runs the alarm with a red signal. If the system is in automatic mode then it activates the automatic brake otherwise it works according to Loco pilot's decision. If there is no obstacle found then it shows the green clearance signal. A flowchart of our proposed anti-collision system is shown in Fig-1.

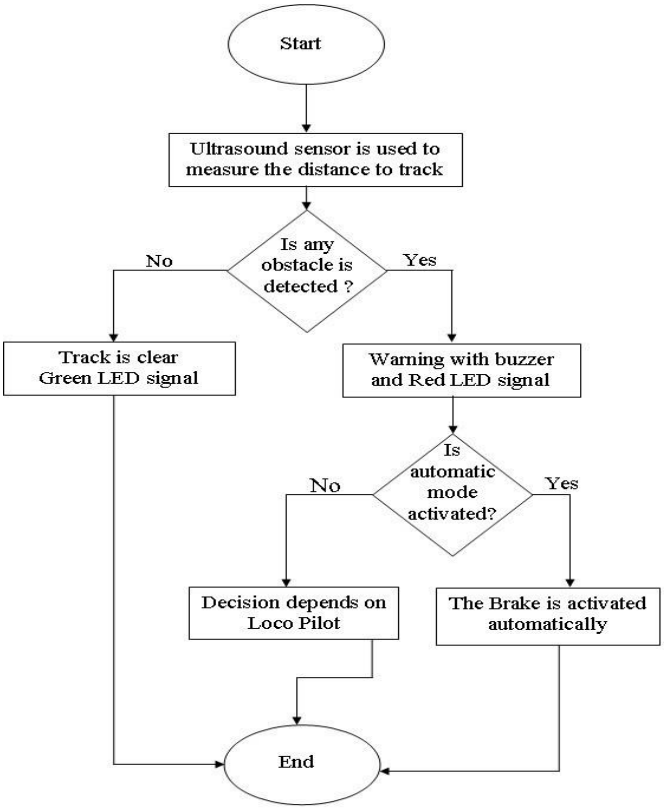

Fig-1: Flowchart of proposed Anti Collision System.

This flowchart (Fig-1) represents our proposed anti-collision system (ACS) working processes. There is an Ultrasound device which always check obstacle in front of the train and measured distance from sensor end to track. If there is no obstacle then it will show green signal and display track clearance message. If obstacle is detected then it will warning with buzzer and red signal and display obstacle distance from the train. In this Anti-Collision Device (ACD) there is a switch to select automatic or manual mode. If an automatic mode is activate then the emergency brake active automatically and control the train. On the other hand, if the manual mode is active then it will detect an obstacle and warn to responsible loco pilot to activate the brake for control the train manually.

3. SYSTEM SETUP

In this system Fig-2 we have used a microcontroller ATMega328p, Ultrasound sensor, Buzzer, Servomotor, Control Device (LCD Display, LED light (Red, Green) and switch).

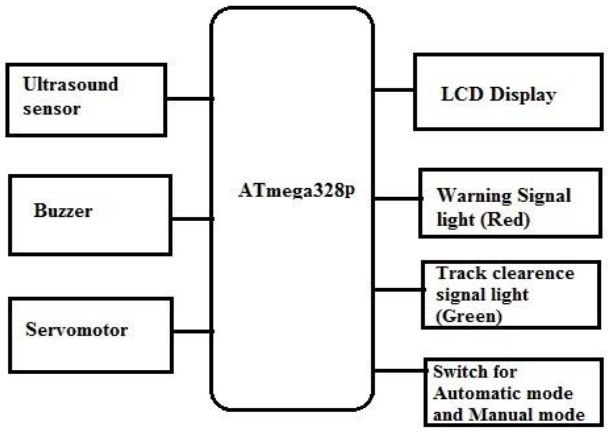

Fig-2: Anti Collision System module.

1) Ultrasound Sensor:
Ultrasound sensor is a high frequency sound sensor. It produces frequency higher than 20 kHz. Which is non hearable for human being. Usually ultrasound transducer devices convert the sound into ultra sound. Ultra sound transmits and receive signal with transducer device where the speed of ultra sound signals depends on the environment shown in Fig-3. It will enable to find an object into selected range. Its count an object as an obstacle if the object like as humans, vehicles, big trees or more than bigger object. In air sound speed 345 m/s approximately, in water the speed of ultra sound is 1500 m/s approximately and in metal the speed of ultra sound is 5000 m/s approximately.

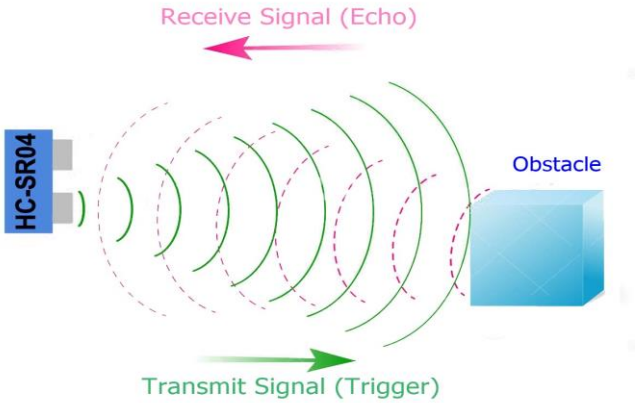

Fig-3: Receive and Transmit signal between ultrasound and obstacle.

2) Microcontroller ATMega328p:
Microcontrollers are used in automatically controlled products and devices, such as automation machine control systems and other embedded systems. The ATmega328p is a single-chip microcontroller created by Atmel in the mega AVR family. The Atmel 8-bit AVR RISC-based microcontroller combines 32 KB In System Programmable (ISP) flash memory with read-while-write capabilities, 1 KB Erasable Programmable Read Only Memory (EEPROM), 2 KB Static Random Access Memory (SRAM), 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, Universal Synchronous/Asynchronous Receiver Transmitter (USART), a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. The device achieves throughput approaching 1 MIPS per MHz.

3) Servo Motor:
A servomotor is a rotary or linear actuator that allows for specific control of angular or linear position with velocity and acceleration. Servomotors are not a specific class of motor although the term servomotor is used to refer a motor which is suitable for use in a closed-loop control system. In this collision avoidance system a servomotor works for turning air brake (automatic brake) at emergency situation shown in Fig-4.

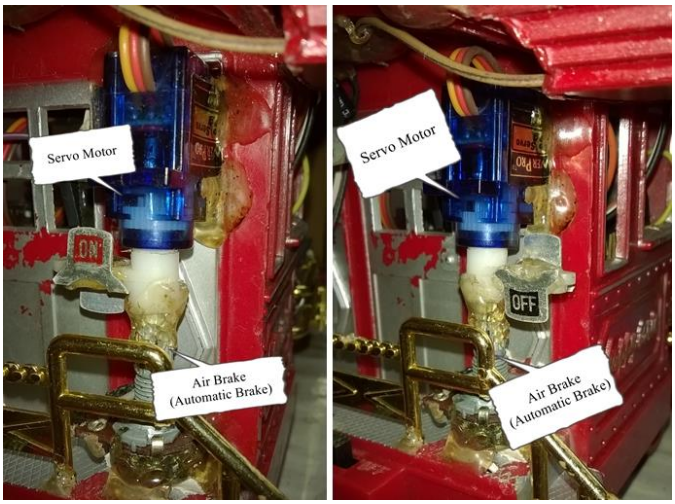

Fig-4: Working system of servo motor on air brake.

4) Automatic Air Brake
Air brake is the standard, safe and effective braking system with compressed air. It is also known as Westinghouse Air brake. Air brake used by railways all over the world. It has an air reservoir and triple valve. But some modern air brake has two or three air reservoir tank. An air reservoir charged the cylinder with triple valves. When a train active the air brake then compressed air released from the reservoir and reached to brake cylinder through the pipe line. An air brake compressor is usually capable of generating a pressure of 90 psi (620 KPa). All over the world, air brake is used as an automatic brake in emergency situation and can reduce the speed rapidly.

5) Control Device:

Control device is a part of anti-collision and embedded system. This device specially designed for loco pilot (which shown in Fig-5 and Fig-6). Control device has various types of components. A loco pilot gets update information of the track's current situation from LCD display. There is a switch to select automatic mode or manual mode. An automatic mode detects collision object, give warning and at last active automatic brake for reducing speed up to zero and stop the train. On the other hand, in manual mode it can detect an object before collision and warn to responsible loco pilot so that he/she can control the train manually. In control device there is a toggle switch. If the switch lever goes up then the manual mode will be activated and automatic mode will be activated when the switch lever goes down. There are also two types of light to give signal. High focusable LED light is used for warning. When any object is detected then it will blinking and a green light LED depicts the clearance. There is also a tuner for tuning contrast level of LCD display.

Fig-5: Our designed control device (Front side).

Fig-6: Our designed control device (Back side).

4. RESULT

This experiment comprehends that, it is one of the efficient and dynamic systems for collision object detection and anti-collision system. This technology is based on ultrasonic sound and an embedded system. It has been implemented both in hardware and software module which is capable of preventing any collision between objects and the train when it is in automatic mode at a specific distance. In this experiment we have used a round track and an engine of a toy train where we have included our system. After placing the train on the track, it moves freely in absence of any barrier on the track. Next, a barrier is placed on the track. Since the train detects the obstacle using our system, it gradually slows down the speed by initiating the air brake and finally stops before the collision takes place. Green and red LED signals indicate presence of no obstacle or obstacle respectively. Our experiment is shown in Fig-6 and Fig-7.

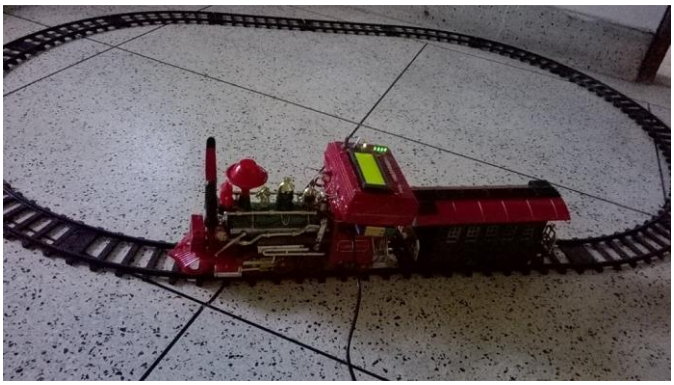

Fig-7: Experimental**.** No barrier is on the track.

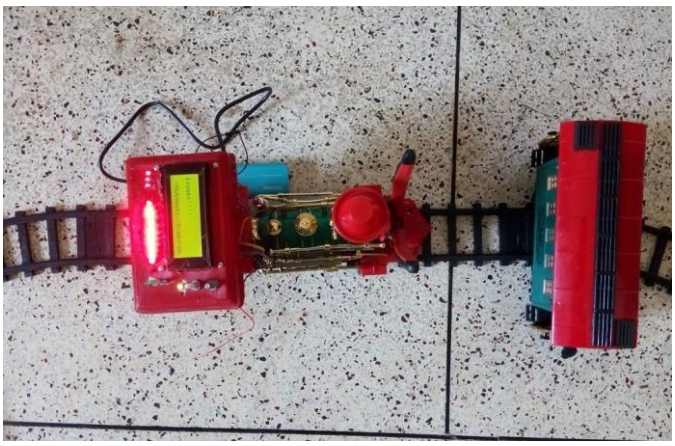

Fig-8: Experimental**.** A barrier is placed on the track.

In Fig-7 there is no obstacle on the track, therefore the train moves freely. On the other hand, in Fig-8 the train stops after observing an obstacle on the track.

4. CONCLUSION

In this paper, we have designed and implemented an innovative technology for collision objects detection and avoiding technique that can prevent any kind of collision with train efficiently. We are confident that incorporating our Anti Collision System with Railway system, it is possible to improve the safety of Railway.

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BIOGRAPHIES

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